Tevatron Alignment Review Close-out

July 22, 2004

A review of the Tevatron Alignment plans for the upcoming Fall shutdown was held on 2004 July 14 at 9:30 a.m. in the Penthouse. The committee consisted of Mike Syphers (Chair), Peter Garbincius, and Jerry Annala. The Charge to the Committee was to review the shutdown aligment plan, the scope and value of each sub-project and readiness, and to provide recommendations on priorities and issues to address/resolve before the shutdown. The review consisted of a single presentation by Jim Volk, with a part of the presentation augmented by Norman Gelfand. Many others were in attendance, including members of the Tevatron Department (AD), the Alignment and Metrology Group (PPD), the Mechanical Support Department (AD), and the Integration Department (AD). A copy of Jim's presentation can be found at

http://home.fnal.gov/ ∼volk/shutdown04/review/

The presentation consisted of the following topics:

- Roll measurements
- Cold lifts
- Kaiser coil measurements
- Shimming of dipoles
- Stand replacements
- Low beta quads and separators
- New installation
- Tev alignment
- TEV NET (N. Gelfand)
- Water levels

Summary of Committee Comments

A much more comprehensive review of Tevatron alignment issues, procedures, and priorities was held in July of 2003. (See http://www-bd.fnal.gov/run2upgrade/reviews/Tev_align.html.) During that review, procedures for aligning magnets cold (especially involving magnet rotations), the development of the TEV NET alignment network, and other important issues were discussed at length during two separate meetings. The purpose of the present 2-hour review was to look over the list of topics for the upcoming shutdown, and to review priorities and look for missing items.

Overall, the Committee felt that the presentation well represented the work to be performed and the list was more or less complete. The major issue agreed upon by all Committee members was that of manpower, especially for alignment personnel. Of the above jobs/issues listed, the ones that require alignment personnel are: Low beta quads and separators, New installations, Tev alignment, Stand replacements, and Full Level Run (TEV NET). These items are listed roughly in order of priority (by at least once Committee member).

Presented below is a list of comments or questions resulting from the Review. Much of this list is taken from remarks by the Committee members through emails to the Chair which are attached at the end of this document.

1. Alignment work needs to be prioritized, especially in the form of ordered lists for stand replacement and realignment of quadrupoles and dipoles, as the work presented may not be all performed during the shutdown due to manpower constraints.
2. The Level Run should be performed.
3. Alignment instructions for the A0 region need to be optimized, as there are many jobs to go on in this region. Aperture studies with beam prior to the shutdown may be required.
4. Survey of the affected element should be performed after a stand change, with dial indicators used on upstream and downstream elements during the change to monitor any motion. As-founds prior to a stand change could be eliminated if manpower does not exist.
5. The E0 collimator change out should be part of the alignment work list.
6. The misalignment of the D0 separators should be understood, if possible.
7. Items that can be performed during short maintenance periods prior to the shutdown should be identified as soon as possible.
8. While there is still time to do this, some job definitions and time scales need to be further detailed:
    - which magnets are to be shimmed?
    - are SNEG pipes to be installed at CDF and D0?
    - which magnets to be unrolled, vertically aligned?
    - which stands to be replaced?
9. Roll measurements and cold lift searches for broken anchors, including Kaiser coil measurements for those dipoles with suspected broken anchors, should all be performed.

10. Laser tracker as found for the entire ring would be nice to fit in, but is probably too much for this shutdown given the number of other tasks to be performed.

11. While the hydraulic level sensor system does not entail alignment per se, the committee believes that installation of this system should go on, consistent with the overall technician availability.

Emailed Comments

From G. Annala

Thoughts from the alignment review meeting

Some of the jobs covered in the meeting do not involve alignment group personnel, and are therefore not in need of prioritization. Those jobs will just take place. The jobs that require alignment will need to be prioritized by the Tevatron people, and then the Division management will have to make decisions about priority between machines. The Tevatron jobs that require alignment are:

1. Low Beta Quad and Separators
2. New Installations
3. Tev alignment
4. Stand replacement
5. Full level run

These jobs are listed in the order of priority in my opinion (we should discuss this order). The level run sounds like something that needs to take place regardless of where it falls in our priority list. Items 1 and 3 will be impacted by info obtained after the shutdown begins, and we should realize this ahead of time. Stand replacement is a job that is easy to trim down to a smaller list if manpower shortages become an issue. The only stands we will be forced to change would be devices that have to move. In these cases, alignment is necessary anyway. Tev alignment is another item that can be adjusted to reduce the magnitude of the job. We should get more people looking at the present data to get a better idea about the number of moves that look like big pay offs.

Questions that still need to have input from Tevatron Department:

What are the optimum alignment instructions for A0. It would seem that we want the beam to be centered through the quads, and then all obstructions, such as the dumps, should be moved to be in their optimum location relative to the beam. I am not sure that this concept is included in the plan. Is there a need for beam study on this issue before the shutdown begins? I think this is a question that Bruce should comment on.

For the stand changes, I think that a dial indicator should be placed on the upstream and downstream devices while the work is going on to make sure the adjacent magnets do not move. I dont think that the alignment group needs to survey all three magnets before and after every stand change. Doing an as found before the stand change is probably a good idea, but that may be something that can be eliminated if the man power is short. I do think that a survey should be done after a stand change (only the device with the new stand).

Misc:

Changing the E0 collimator should make it onto the alignments group work list.

The misalignment of the D0 separators is suspicious. It would be nice if we could understand the source of the movement.

Some of the work may be able to take place before the shutdown begins. I am thinking of as founds at E0 and A0, stand stake outs for the crystal collimator and IPM as well as for the new collimator. The details of these jobs should be finalized as soon as possible so if an opportunity arises, these jobs can be done early. Jim Volk should organize this.

From P. Garbincius

My main concern is the availability of alignment personnel. We will NOT have enough alignment personnel to do everything, so there needs to be some priorities set, based on what short (and long) term gains can be achieved, with some jobs falling off the end of the list.

I also worry about the timescale for definition and prepartion of the jobs, especially the specifications: which device, by how much. This seems to be coming very late (even after the start of the shutdown) for some jobs. Some examples include:

- shimming of dipoles - although not AMG-based, needs specificiation by Mike Syphers and Gerry Annala of which 344 (or less) magnets, symmetric about the distributed sextupole correctors, should be adjusted? Vladimir's "suspiscious" magnets have to be defined early enuf to get on the work list in an efficient order.
- are the SNEG pipes to be installed at CDF and D0, and is the longer collimator going to replace Tokyo pot(s) at A-48? Do these two short alignment jobs have big impact on AMG? I would imagine that the other new equipment installation jobs and alignment would happen in any case.
- how many rolls and vertical offsets should be attempted to be corrected is awaiting the Norman/Leo proposal. The impact on AMG is strongly dependent on how many are chosen to be done: (from separate handout sheet)

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Rolls:  > 1.0 mrad => 29 D + 8 Q = 37 total
                1.2 mrad => 18 D + 6 Q = 24 total
                1.5 mrad =>  7 D + 4 Q = 11 total
V-offset > 2 sigma > 2.8 mm => 36 D + 9 Q = 45 total
           3 sigma > 4.2 mm =>  9 D + 9 Q = 18 total
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  Although these V-offset corrections are greater than the 50 mil = 1.25 mm limit without disconnecting elements. Given the information on the sheet, it is not apparent to me if or how adjacent offsets can be utilized to adjust without disconnecting.

- how many stands need replacement? Of course, those that need but cannot be adjustment due to stand failure and the rusty low Beta quad stands. I was still confused as to whether as-founds (before) are needed for all stand replacements, and this depends on what happens after

the stand replacement. If all goes well and the dial indicators are stable, it appears that there is still some sentiment for an alignment check after. If so, what is the magnet checked against? a beam sheet or against its prior position (which would have to be measured beforehand). If the "theoretical" beam sheet value is available and trusted, then it can be used to re-position in the case of dial indicator slippage, without need for as-founds before stand replacement.

The point is that by carefully selecting the threshold for correction, the amount of work for this task can be substantially reduced. What is the appropriate value from a cost/effectiveness viewpoint? What is the appropriate staging of jobs to insure that all the high priority jobs get done and that, if needed, some of the continuing lower priority jobs fall off the END of the shutdown, rather than occur in the middle?

I don't worry about the roll MEASUREMENTS, the cold lift and Kaiser coil measurements both for sextupole correction and for searching for broken anchors and shimming adjustments, nor for the water level sensors. None of these jobs involve AMG personnel, although TD and AD/Ops and Tevatron people are needed. HOWEVER, if a magnet needs replacement due to a broken anchor or field roll relative to iron, then they do become a task for AMG. I guess we could decide whether such a problem should, or can afford to, be fixed this shutdown.

Looking over Bob Bernstein's spreadsheet/graph (which was distributed on Friday, July 9, not at review), the three biggest jobs requiring AMG are:

Tev Level Run	20 calendar days	starting Sept 13
Stand Replacement	20 calendar days	starting Sept 13
Re-Align Quads/Dipoles	54 calendar days	starting Oct 4

All the other Tevatron alignment jobs, either higher or lower priority, fit around these big 3.

The Tevatron Level Run is needed by AMG to verify TeVNeT so it should be done, and options for prioritizing/reducing the Stand Replacement and Q/D Re-Alignment have been discussed above. I note that the Re-Align continues on RHBOB's spreadsheet through Nov 26, more than the 13 week length of shutdown.

Ray Stefanski has asked for a Laser Tracker as found for the entire ring. Although this would be nice data, Bernstein estimated 6-7 weeks (or 42-49 calendar days) for this task. Off the top of my head, I think this is prohibitively expensive.

End PHG comments.